A COMPARATIVE STUDY OF OBSERVING SURGICAL OPERATIONS THROUGH CLOSED - CIRCUIT TELEVISION WITH DIRECT OBSERVATION

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P.N.K.

C O N T E N T S

A view of crowded operating table. Mark the position of subjects at extreme left and the space occupied by surgical instruments.

S E C T I O N I

INTRODUCTION

Television has already established itself as a successful audio-visual aid in the technologically advanced countries. With its ability to convey life and events in action, it can bring to a classroom tremendous range of experiences, with picture as well as sound, to give a vivid impression to the students. While regular TV broadcasting can be used for teaching any subject, closed-circuit television is more useful in specialised areas such as medical education and job training in industry and commerce.

In India educational television is hardly two years old. In October 1961 television was introduced in Delhi under the Delhi School Television Project to the ninth grade pupils of 150 higher secondary schools. This has been an experiment in educational television broadcasting. To the best of the knowledge of the investigator, no work has been done in India on the use of closed-circuit television, especially in medical education. Since it is a very effective audio-visual aid it can be useful for solving some of the special problems associated with training in surgery.

A major probelm in India for an instructor in medical education is that of ensuring that students get an effective close-up view of the demonstrations of delicate techniques of surgical operations. The method of such demonstrations hitherto has been confined to small student groups or to large theatres in which only remote observation is possible.

The present study was undertaken to explore the possibility of increasing training facilities available in medical institutions. It seemed reasonable that if some way could be found to enable more students to benefit from the use of closed-circuit television, this study might be a contribution in the field of medical education.

LIMITATIONS OF THE METHOD OF DIRECT OBSERVATION OF SURGICAL OPERATIONS.

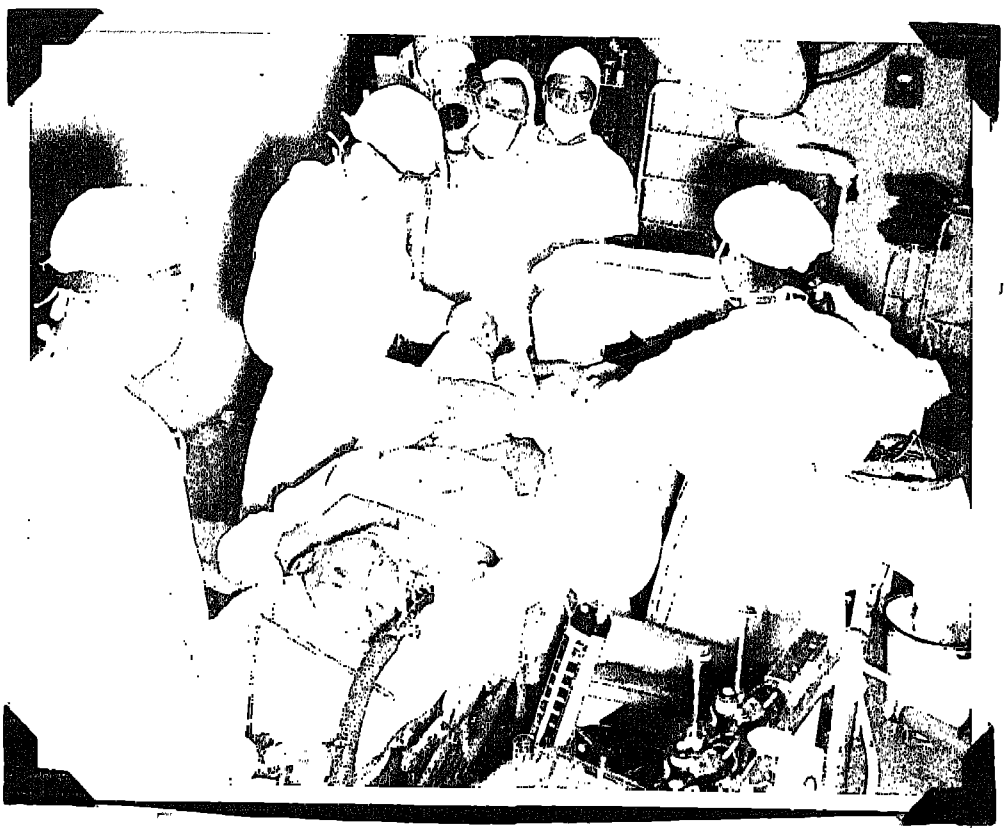
The present method of direct observation in the operation theatre, prevalent in most of the medical colleges in India, has certain limitations which may be summarized as follows:

1. A limited number of students can be accommodated in the operation theatre for observing the operations because
   i) the operation table is surrounded by the surgeon, his assistants, surgical equipments and instruments and therefore there is not much room left to accommodate the students;
   ii) for the efficient working of the surgical staff the operation theatre cannot be overcrowded.
2. Not all the observing students can go into the minute details of the operation.
3. The crowded operation table may distract the connentration of the operating surgeon and may spoil the atmosphere congenial for operation.
4. Under certain circumstances direct observation may cause physical inconvenience to the students when operation is not visible clearly from certain standing positions or it is so long that they feel tired.

ASSUMPTIONS UNDER WHICH THE PRESENT STUDY WAS MADE

The present study was undertaken with the assumption that the above limitations may be overcome by observing the operations on closed-circuit television which has the following advantages:

1. The camera eye can go virtually anywhere close to the operating table.[1]



A view of operation theatre - see how camera man is trying for best picture.

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[1]Charles S. Cameron, Five schools linked together for television teaching, p. 1077-1081.

2. Unlike human eye the camera lens has the capacity to magnify images, and therefore is able to express clearly any point in the operated organ.
3. By increasing the number of the receiving sets TV can serve as many students as desired.

SPECIFIC PURPOSE OF THE STUDY was to determine whether undergraduate students of medical colleges could see more details of an operation through closed-circuit television than through the conventional method of direct observation in the operation theatre.

HYPOTHESIS

Looking to the advantages of closed-circuit television it was scientifically hypothesized that observation through closed-circuit television is a more effective method of viewing surgical operations for undergraduate students of Indian medical colleges, than the present method of direct observation in the operation theatre. Statistically stating (null hypothesis) the method of observing surgical operations through closed-circuit television is as effective as the method of direct observation in the operation theatre for undergraduate students of Indian medical colleges.

Since it was an exploratory study the findings may not be generalised until they are confirmed by further such studies on a larger number of subjects, with greater number of different types of operations at different places in the country.

S E C T I O N II

PROCEDURE

EQU IP ME N T USED

The experiment was carried out with the help of closed-circuit television. Stated simply, closed-circuit television provides for the electronic transmission and reception of images within a definitely prescribed area. It is comparable in effect to an intercom or central sound system except that it provides both sound and picture simultaneously. It may be of interest for the reader to know the chief distinction between a "closed-circuit television" and an "open-circuit television" (or broadcast television), with which we are more familiar in India. In the closed-circuit television the program transmission is carried out entirely within the cable circuit of the distribution system and is therefore not receivable except on television receivers connected directly to line terminating "out let boxes" of the distribution system, whereas, with broadcast television messages are open to reception by any set owner who tunes to that channel in the transmitter coverage area.[1]

The equipment used consisted of

i) TV Camera with movable stand.
ii) Zoom Lens.
iii) Remote control unit.
iv) TV Receivers.
v) Microphones
vi) Sound system including amplifiers.
vii) Spotlights.

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[1]Irvingr Merrill, closed-circuit television in health science education, p. 329-338.

To maintain contact between the surgeon and the subjects on TV a two-way sound communication system was provided.[2]

SUBJECTS FOR STUDY

The subjects for this investigation were chosen from the undergraduate students of All India Institute of Medical Sciences. These were in all thirty six, representing seventh, eighth and ninth semesters.

Due to the limitations of time and resources it was considered proper to carry out the experiment in only one of the three medical colleges of Delhi. Since All India Institute of Medical Sciences extended all the requisite facilities it was considered proper to take up the experiment in that institution.

Selection of the subjects was restricted to the last three semesters only due to the fact that the students of the first six semesters were not considered fit, their knowledge in the field of surgery being not upto the mark. The number of the students selected for the study was mainly dependent upon their availability, but this number was the least with which three groups could be formulated as described in the subsequent lines under experimental design.

EXPERIMENTAL DESIGN

Design of Study: To carry out the investigation the simplest design would have been to have two groups of subjects and to show the same operation to one of the groups on TV and to the

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[2]Charles S. Cameron, Five schools linked together for television teaching, p. 1077-1081.

other through direct observation in the operation theatre and to compare the results. In this design the differences in the scores on examination to be conducted after the subjects had viewed the operation could have been due to:

i) differences in the two methods
ii) individual differences among subjects
iii) the fact that there was only one operation

but since the effect of methods could not be separated this design was not used.

A better way of approach was to replicate the experiment with a similar or a different operation on two more groups of subjects or the same groups of subjects as used in the earlier design. But the difficulty here was that in case the results of one experiment supported one method and that of second experimen supported the other method no conclusion could be drawn. Moreover, the number of experiments being only two, no generalisation about the methods or operations would have been possible. To avoid the above stated short comings, four experiments, instead of two, would be possible by increasing the number of operations and groups. But even in this design the probability of distinguishing the two methods of observation would not have been much. To increase the probability, the only possible way that appeared was further replications of the experiment. Keeping in view the availability of students and limitations of time and resources, the investigator confined the experiments to six. The design of the study would be as given in Table 1(page 8).

For convenience sake instead of showing six groups in the design only three groups have been indicated and each group divided into two subgroups called (a) & (b).

Table 1. Design of the Experiment.

Operation	Direct Observation	Television
A	I*(a)	I (b)
B	I (b)	I (a)
C	II*(a)	II (b)
D	II (b)	II (a)
E	III*(a)	III (b)
F	III (b)	III (a)

*Group number.

In the above design the sequence effect is nullified as one half of the group saw the operation on TV first and the other half through direct observation first and this process was reversed for the second operation. Individual differences have also been accounted for as each individual saw an operation on TV as well as through direct observation. The operation effect was nullified as each operation was viewed by both the subgroups. The effect of practice was not there as every time a different operation was to be viewed by the individuals and the questions to be asked after the operation were to be of specific nature and not general.

The design of the experiment was such that it hardly mattered if the operations varied in difficulty or there were individual differences, and as such random selection of the operations or the subjects was not necessary.

Formation of Groups: The thirty six subjects available for the study were divided into three groups of twelve each in such a way that each group represented all the three semesters. This was done with a view to nullifying the effect of

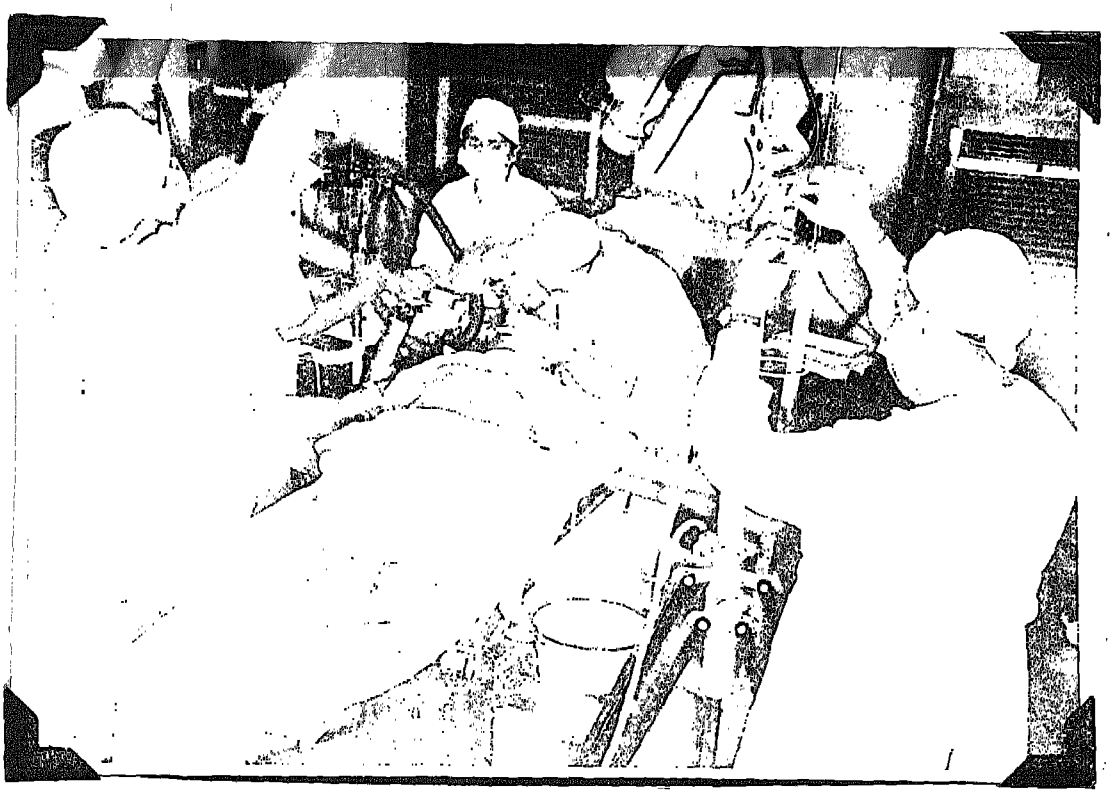
semesters, if any, on scores through a particular method and to generalise the findings. Each of these three groups was divided randomly into two equal subgroups (a) and (b) to have two comparable groups, one of which could see a particular operation on TV and the other in the operation theatre. In all six operations were shown and each group observed two operations one on TV and another through direct observation.

The subjects in the subgroup I(a) first observed the operation (A) through direct observation and then operation (B) on television; while those in the subgroups I(b) observed the operation (A) on television first and then operation (B) through direct observation. Similarly the groups II and III observed the operations (C) and (D) and (E) and (F) respectively.

PILOT STUDY

Before the actual observations a pilot study was conducted in which a number of operations were shown to a group of students (not included in the final study) to see whether the picture on the TV screen could give details of the operations. Another aim of this study was to make the surgeon adjusted to the existence of TV equipment especially the microphone and the presence of the technical officer and his staff, in the operation theatre. It was also expected from the pilot study to suggest certain points where precautions were to be taken.

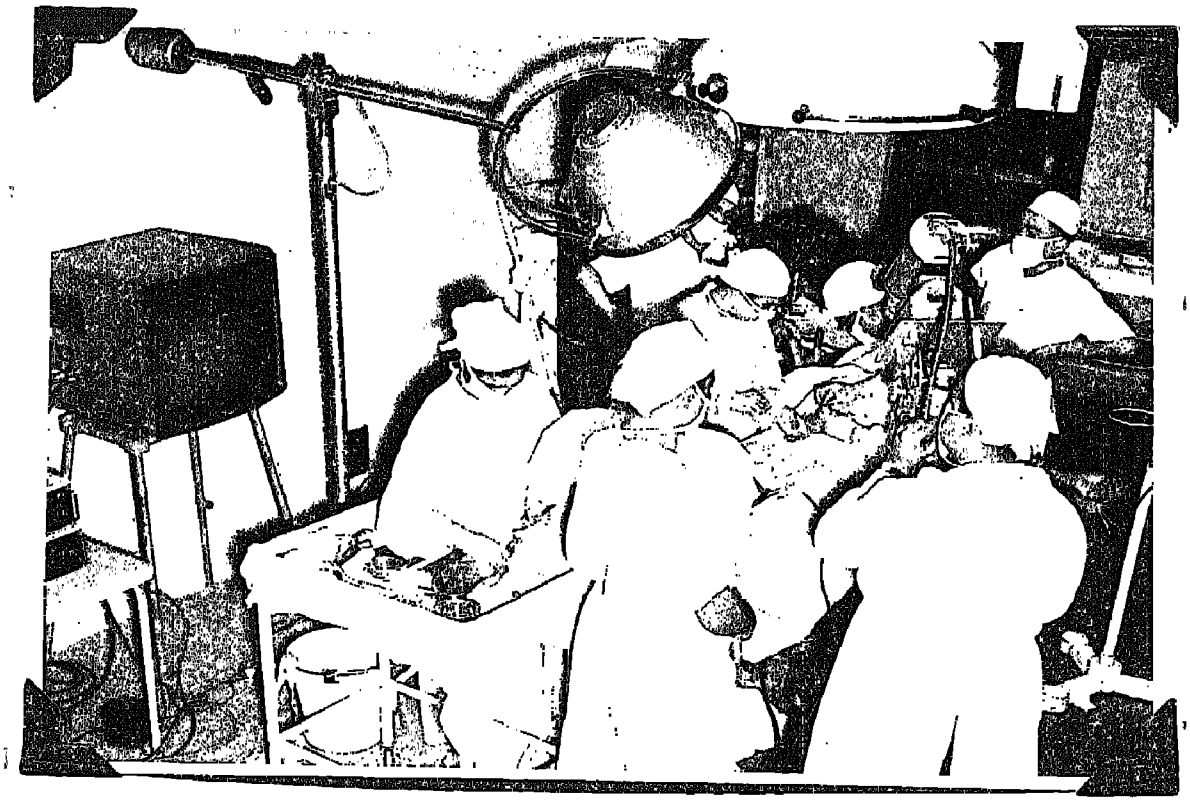
ARRANGEMENTS & PRECAUTIONS TAKEN



Arrangement of equipment for operation.

Equipment: The TV camera mounted on its movable stand was placed very close to the operating table in the operation theatre; and the lens of the camera was focused on the operation field. Equiping the camera with zoom lens extended the usefulness of the system as in the wide angle position the camera could compass the entire surface of the operating table, while with more restricted angles the entire TV screen could be filled with the enlarged image of the operation field. There was a double control on the TV camera one by the camera man and the other through the remote unit installed in the

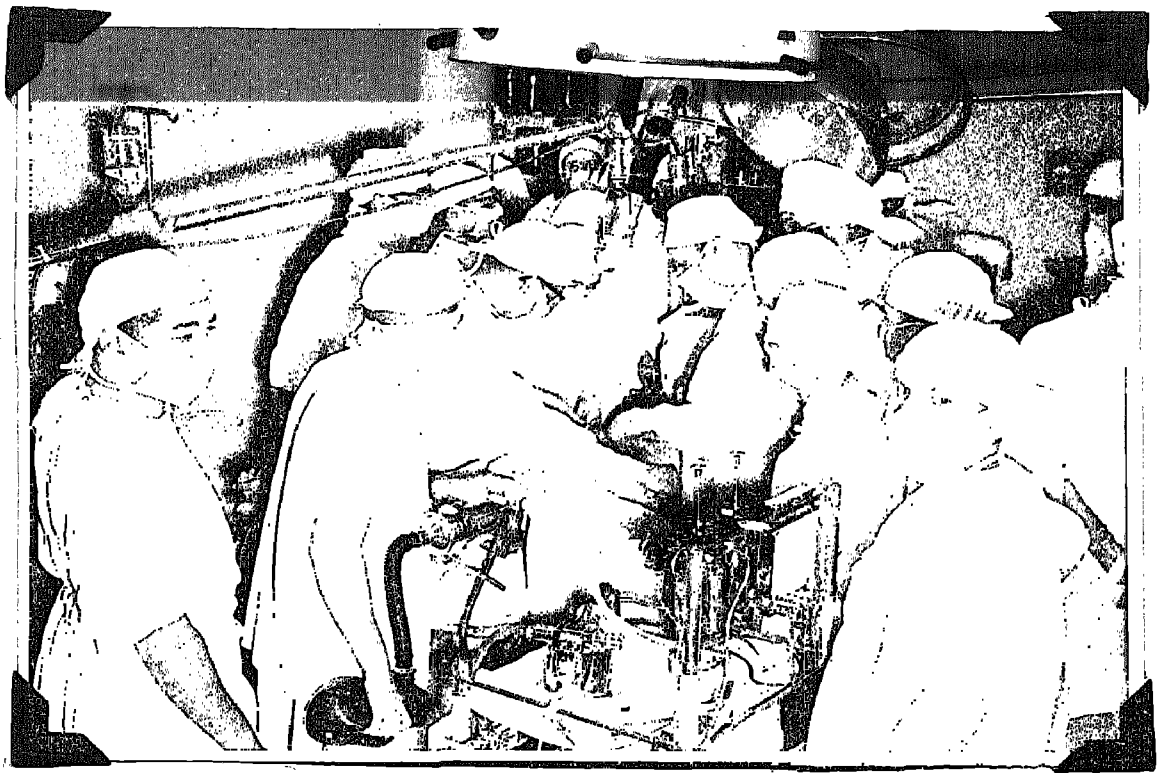
operation theatre and adjustments could be made from either point.



Operation in progress. Note position of TV receiver and control unit placed on the table.

The main TV receiver was installed in a small lecture room (TV room), which was at a distance of about 150 feet from the operation theatre. Microphones, together with the necessary amplifiers, were provided, both in the operation theatre and in the TV room to enable the surgeon to explain the salient points of the operation and the

subjects in the TV room to ask questions or seek clerifications from the surgeon whenever they had a doubt. An assistant engineer was posted in the TV room to take care of the receiving set and sound system and to make adjustments in the same if necessary.



Another view of crowded operating table - Note the position of microphone.

A second receiving set was provided in the operation theatre so that the camera man could see the picture and make the adjustments, if required. Besides the normal operation theatre lighting, an additional spotlight was provided.

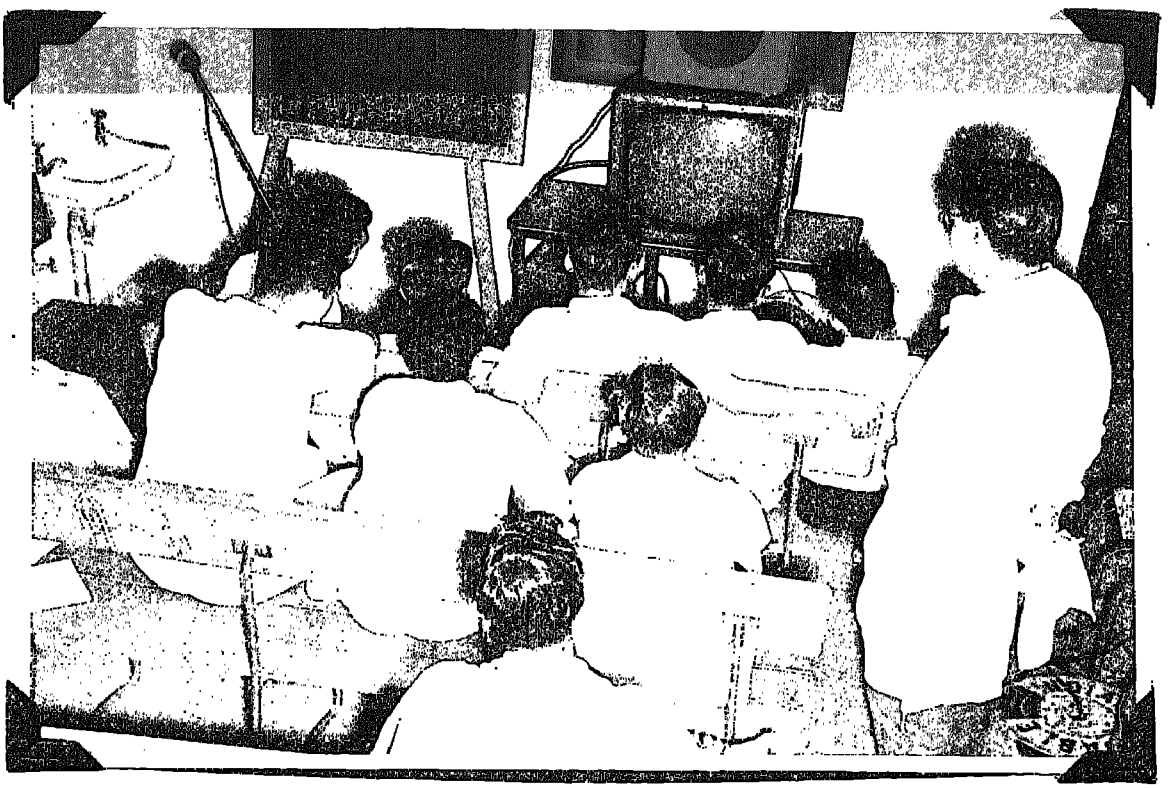
Arrangements of the equipment had to be discussed with the surgeon before the start of every operation as it varied with the organ to be operated and the position to be occupied by the surgeon.

The following precautions were taken:

1. The TV receiver in the operation theatre was placed in such a way that the subjects present in that room were not able to see the picture on its screen.
2. The camera lens was so adjusted before the actual operation started that it could get the best view of the operation field and avoid, as far as possible, the interference caused by the surgeon's hands or head coming in the way.
3. Care was taken to place the remote control unit at a distance from the operation table to avoid over-crowdedness near this table.
4. The microphone in the operation theatre was so installed that it could be brought quite close to the surgeon's mouth.
5. Normal operation theatre lighting was adequate while televising pictures from surface of the body, but care had to be taken to mount extra spotlight on the TV camera itself, when the normal lights did not reach the interior of the body where the operation was being conducted.
6. All the TV equipment was cleaned as scrupulously as any other equipment in the operation theatre

to avoid infection.

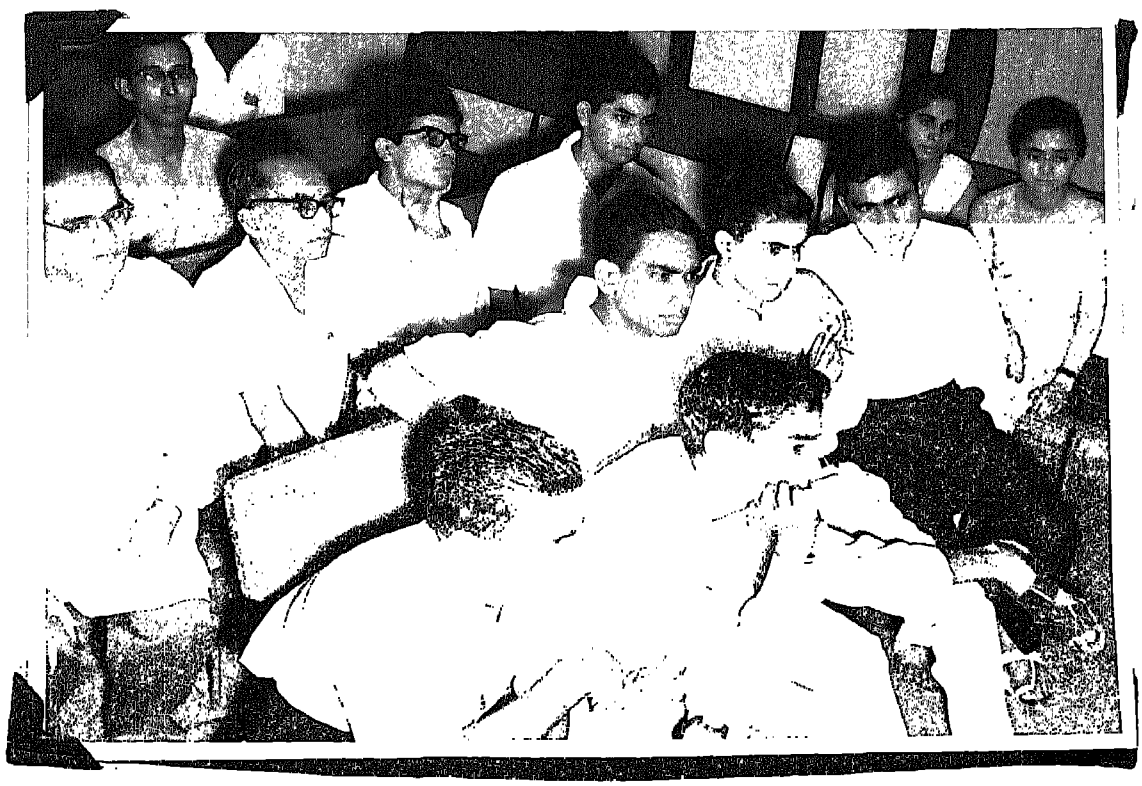
7. The surgical linen used during the operations were of dull green colour as white textiles and highly polished instruments ruin the televised picture.



A view of TV room when operation in progress inthe operation theatre.

Subjects: Out of the three groups of subjects selected for the study only one group was called on a particular day for viewing the operation. After the subjects were convinced of the importance of the study and the required rapport was established they were divided randomly into two equal subgroups,

one for the operation theatre and the other for the TV room. The subjects were informed that a brief test would be given soon after the operation, for finding out what they had learned from it. They were however, assured that the results of this examination would in no way effect their college examination scores. The next date on which those subgroups had to view another operation was also announced.



Another view of TV room. Note the concentration of the group.

Surgeon - Made Test: After the close of the operation the surgeon was immediately approached for a questionnaire on

that particular operation. Care was taken to get this questionnaire at the earliest possible moment to avoid the slipping away of the subjects or discussion among them over that operation. Because it was impossible to frame questions before the operation was performed therefore no question of their tryout could arise. The number of questions was limited to five because it was considered enough by the surgeon to cover the main points of the operation.

S E C T I O N III

COLLECTION OF DATA

APPROACHING THE SURGEON

The investigator approached the surgeon of the All India Institute of Medical Sciences who would be performing operations; his cooperation was very necessary.

Because the role of the surgeon was important the investigator gave much thought to the way he should be approached. One of the possible ways was through an introductory letter from the Director of the Research Methodology Training Course for any or all of the three medical colleges in Delhi. But this was not considered enough to go ahead with the study, as it might not create much interest on the part of the medical authorities to extend all the necessary facilities. Further, the Director of the aforesaid course was likely to introduce the investigator simply as a trainee, which was not expected to be so impressive.

A better alternative was to have an introductory letter from the Director of the National Institute of Audio-Visual Education, New Delhi, to which the investigator originally belongs, and to be introduced as an official of that Institute rather than as a trainee, but the difficulty was that it would have been from a person who was not known to the Principals/Directors of these colleges and as such might not have got proper weightage.

It was thought best to be introduced by someone in the medical field and if possible in the field of surgery.

In this connection the Director of the All India Institute of Medical Sciences was approached through personal sources, who introduced the investigator to the surgeon concerned. The investigator also tried the other two medical colleges of Delhi,i.e. i) Lady Harding Medical College, New Delhi, and ii) Maulana Azad Medical College, New Delhi. Since the talks with the Principal, Lady Harding Medical College were not encouraging, the investigator left the idea of taking up the study in that college. The Principal, Maulana Azad Medical College was on leave; so it was thought that in his absence the required facilities might not be provided.

The surgeon concerned at the All India Institute of Medical Science helped in the following ways:

1. In extending necessary facilities for televising operations by providing space in the operation theatre for fixing of TV equipment and making available a room for televising.
2. In selecting the subjects for study.
3. In selecting appropriate operations, to be televised, keeping in mind that they were to be more or less of the same difficulty value.
4. In preparing questions on a particular operation and scoring the answer sheets.
5. In extending all administrative facilities such as providing a room for storing TV equipment, when not in use, making available gowns, masks and caps to the investigator and staff assisting him, and also for introducing

the investigator and his team to other surgeons and surgical staff which made the movement of these persons unrestricted in the operation theatre.

DIFFICULTIES FACED

Following are some of the difficulties which are worth mentioning here for the knowledge and interest of the reader.

1. On some occasions the dresses, (i.e. gowns, masks, and caps) required for entering the operation theatre went out of stock with the result, the subjects were not permitted to enter the operation theatre. This difficulty was overcome by discussing it with the surgeon and making green dresses available to the subjects, which otherwise were strictly meant for the surgeon and the staff who work on the patient.
2. Sometimes the subjects found some difficulty in sparing themselves at the time of the operation because they were already occupied with other assignments. This was overcome by consulting the surgeon, heads of the departments and the subjects concerned, and making changes in the daily college schedule for that particular day.
3. The surgeon who was assisting in the experiment was not the person in-charge of the whole

operating block of the medical college. Somehow on one occasion due to some adjustments made by the person in-charge of the operating block, the room given for fixing the TV receiver could not be made available to the investigator, with the result that the TV equipment, which was normally fixed before the arrival of the surgeon could not be set up. The matter was discussed with the surgeon, who was kind enough to agree to postpone the operation for about 45 minutes and also to suggest another room for fixing the equipment.

4. The operation which was to be televised on a particular date was sometimes not performed either because of administrative reasons or the physical condition of the patient to be operated. To avoid this, the surgeon was requested to fix the same date for operating two cases suitable to be televised for the purpose of the study. In this way the probability of missing an observation at the fixed date was reduced.

5. On certain occasions some of the subjects were not inclined to go to view the operation directly or on TV, as instructed. They were convinced by the investigator of the importance of the study and their role in such an experiment and,

therefore, ultimately they got sufficiently motivated for the task.

6. Inspite of the fact that the subjects were sufficiently mature to understand the purpose of the study, a few of them sometimes did not cooperate in giving responses to the questionnaire handed over to them after they had viewed the operation. Some of them who were reluctant to come for the second observation were given curioes as incentives.

7. The surgeon had no time to prepare the questionnaire which was to be given to the subjects soon after they had viewed the operation. If he delayed the preparation of the questionnaire, the subjects could have either slipped away or have discussed their observations among themselves. To avoid this as far as possible, the surgeon was requested to dictate the relevant questions during the time he washed and relaxed in his room, after finishing the operation. These questions were noted down and given to the subjects immediately by the investigator.

8. Sometimes the subjects in the TV room were talking among themselves. They were asked to pay proper attention to the TV. They were further told politely that the investigator did not expect the need of any teacher to control such a mature class. So they became serious.

9. The operating surgeon sometimes forgot to use the microphone while explaining certain things to the students in the operation theatre. With the result, the students in the TV room could not listen to him properly. To check this source of error, the surgeon in a first few cases was reminded of the use of the microphone. But later on, he got used to it.

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S E C T I O N IV

ANALYSIS AND INTERPRETATION OF DATA

PRESENTATION OF DATA

The distribution of the examination scores obtained by 36 subjects on TV and direct observation are shown in Table 2.1, 2.2, and 2.3 . Difference between individuals scores on TV and direct observation, and the sum of the scores obtained on the two methods, are given in columns 7 & 8 of these tables. Scores have been given out of a total of 10 marks.

Table 2.1 Examination Scores for Group I

		OPERATION-A		OPERATION-B		T-O	T+O
Group	Subject	O*	T**	O	T		
1	2	3	4	5	6	7	8
I(a)	1	7.0			10.0	3	17
	2	8.0			6.0	-2	14
	3	8.0			10.0	2	18
	4	9.0			7.5	-1.5	16.5
	5	4.0			10.0	6	14
	6	9.0			10.0	1	19
I(b)	7		10.0	9.0		1	19
	8		9.5	8.5		1	18
	9		10.0	7.5		2.5	17.5
	10		10.0	7.5		2.5	17.5
	11		8.5	7.0		1.5	15.5
	12		10.0	8.0		2	18
Total		45.0	58.0	47.5	53.5		
OPERATION TOTAL		103.0		101.0		19.0	204

* Score on direct observation
** Score on TV

Table 2.2 Examination Scores for Group II

Group	Subject	OPERATION-C		OPERATION-D		T-0	T+0
		O*	T**	O	T		
1	2	3	4	5	6	7	8
II(a)	13	7.0			7.0	0	14
	14	9.0			6.0	-3	15
	15	8.0			8.5	0.5	16.5
	16	8.0			9.0	1	17
	17	10.0			6.0	-4	16
	18	3.0			4.0	1	7
II(b)	19		2.5	8.0		1.5	17.5
	20		10.0	7.0		3	17
	21		10.0	9.0		1	19
	22		9.0	7.0		2	16
	23		5.5	0.0		5.5	5.5
	24		9.5	9.0		0.5	18.5
Total		45.0	53.5	40.0	40.5		
OPERATION TOTAL		98.5		80.5		9.0	179

* Score on direct observation
** Score on TV

Table 2.3 Examination Scores for Group III

Group	Subject	OPERATION-E		OPERATION-F		T-0	T+0
		O*	T**	O	T		
1	2	3	4	5	6	7	8
III(a)	25	9.5			8.5	-1	18
	26	9.0			8.0	-1	17
	27	7.0			10.0	3	17
	28	8.5			7.0	-1.5	15.5
	29	8.0			7.0	-1	15
	30	6.5			7.0	0.5	13.5
III(b)	31		10.0	6.0		4	16
	32		10.0	9.0		1	19
	33		8.0	8.0		0	16
	34		8.0	6.0		2	14
	35		8.0	6.0		2	14
	36		6.5	6.0		0.5	12.5
Total		48.5	50.5	41.0	47.5		
OPERATION TOTAL		99.0		88.5		8.5	187.5

* Score on direct observation
** Score on TV

Table 2.1 gives the scores of group I which observed the operations (A) and (B). The subgroup I(a) first observed the operation (A) through direct observation and then operation (B) on TV. For the subgroup I(b) the sequence of observing the operations was reversed. Similarly, the scores obtained by the remaining two groups for viewing operations (C) and (D) and (E) and (F) are presented in Table 2.2 and 2.3 respectively.

Sum of scores on observation and television obtained by each group is shown in Table 2.4. Figures in column 3 of this Table are obtained by adding columns 3& 5 in Table 2.1, 2.2, and 2.3, whereas those of column 4 are obtained by adding columns 4 & 6.

Table 2.4 Showing Group-wise scores on observation and Television.

Group	Operations	SUM OF SCORES O*	T**	Both***
1	2	3	4	5
I	A & B	92.5	111.5	204
II	C & D	85	94	179
III	E & F	89.5	98	187.5
Total		267.0	303.5	570.5

* Total scores on observation
** Total scores on television
*** Total scores on both observation and television.

If one compares the scores in column 4 to column 3 of Table 2.4 one finds that the scores of all the three groups on TV are comparatively better than those of direct observation. This shows a general trend for higher scores

on TV. To see whether this difference is significant a couple of simple non-parametric tests are applied and also analysis of variance is carried out.

NON-PARAMETRIC TESTS

To apply the non-parametric 'median test', the median of 72 scores is calculated which is 8.25. But due to several ties, Table 3.1 gives 39 observations below 8.25 and 33 observations above it. In this test the value of Chi-Square is 4.53 which is significant at 5% level. This seems to suggest that the scores on the two methods are significantly different or that TV scores are on the whole better than those of direct observation, because out of the 33 scores above the median there are 21 $\overset{TV}{\wedge}$ scores and only 12 direct observation scores.

Table 3.1 2 x 2 TABLE FOR MEDIAN TEST FOR ALL SCORES

	Below 8.25	Above 8.25	
Observation	24	12	36
Television	15	21	36
	39	33	**N = 72

$$\text{Chi-square} = \frac{72(504-180)^2}{36 \times 36 \times 39 \times 33} = 4.53^*$$

*Significant at .05 Level.

**N Stands for total number of observations for 36 individuals, there being two observations per individual.

Another 'median test' is carried out to see whether out of the 36 individuals the proportion of those who do well on TV and badly on direct observation differs from the proportion of those who do well on direct observation and badly on TV. Only those scores which are above the median (8.25) are considered as good. The data are presented in Table 3.2. The value of chi-square is 4.26 which is significant at 5% level. This shows that the proportion of those individuals who did well on TV and badly on direct observation is significantly higher than the proportion of those who did well on direct observation but badly on TV.

Table 3.2 TABLE FOR MEDIAN TEST FOR ALL INDIVIDUALS

OBSERVATION

TV	Not above 8.25	Above 8.25	
Above 8.25	14	7	21
Not above 8.25	10	5	15
	24	12	N =36

$$\text{Chi-square} = \frac{(14 - 5)^2}{14 + 5} = 4.26^*$$

*Significant at .05 Level.

Further it is observed that out of 36 individuals 26 scored more on TV and 10 scored less than or equal to what they scored by direct observation method. To see if this suggests anything about the two methods of observation, another non-parametric test is applied.

Denoting by 'p' the probability of getting better scores on TV in comparison to direct observation. The Hypothesis $Ho(p=\frac{1}{2})$ is tested against $Ho(p\neq\frac{1}{2})$. Let 'r' be the number of individuals scoring more on TV. Now if Ho is true,

$$p(r \geq 26 \text{ or } r \leq 10) = 2 \sum_{r=0}^{36} C_r^{36} (\tfrac{1}{2})^{36}$$

$$= 2x.00567$$

$$= .01134$$

which is less than .05. Therefore the hypothesis $Ho(p=\frac{1}{2})$ is rejected. It may be interpreted that the effect of the method of observing operations is systematic and it therefore appears that number of persons having TV scores higher than direct observation scores is significantly greater than what would have been expected by chance. This again, in a way, establishes superiority of the TV method over direct observation.

ANALYSIS OF VARIANCE

The non-parametric tests are however, crude and in order to have more precision in comparing the two methods analysis of variance is carried out. There are many sources of variations in this experiment such as individuals and operations, but not all of these can be eliminated simultaneously from the error. There are two approaches possible. In one approach the error will consist of differences among individuals and differences within individuals and in the other, the error will consist of differences among operations and differences within individuals. Both these analysis have been carried

out and are presented in Table 4.1 and 4.3 respectively.

The analysis of variance given in Table 4.1 is based on the assumption that the error consists of (i) differences among individuals, and (ii) differences within individuals, i.e. between the scores of the same individual under identical conditions. The design of the experiment, however, was such that the sum of squares due to methods is free of the effect of operation to operation variations, individual differences, and sequence of observation (i.e. whether an individual viewed an operation on TV first, then another directly, or vice versa).

Table 4.1 ANALYSIS OF VARIANCE

Source of Variation	Sum of squares	Degrees of Freedom	Mean square	F
Between methods within operations				
Between methods	12.50	1	12.50	5.01*
Operation x Methods	8.17	5	1.63	0.54
	20.67	=6		
Between Operations				
Between sequences	12.02	1	12.02	4.13*
Between operation within sequences	13.31	4	4.70	1.50
	31.73	=5		
Error(within cells)	187.63	60	3.13	
Total	240.33	71		

* Significant at 5% level.

Since 'F' for the 'method from Table 4.1 is significant at 5% level, the hypothesis that both the methods are equally effective is rejected. Further as the average score of the subjects on TV is more than

the average score on direct observation, we may conclude that viewing operations through TV is more effective than direct observation.

It may particularly be observed that the sum of squares due to methods is free of differences among individuals, but these differences are not altogether eliminated from the error sum of squares because an individual is viewing different operations by direct observation and on TV. Had it been possible to eliminate the individual differences from error sum of squares, it would have been expected that the error sum of squares would be less than what it is. Thus, the present error sum of squares is some what inflated. Inspite of this the difference among the two methods has come out to be significant. It suggests that if it were possible to eliminate this individual differences from the error, the result would have been highly significant.

Further, the interaction between the operations and methods is not significant, which seems to indicate that the scores on either method are not affected by variations in the operations.

It may be of special interest to note from Table 4.1 that 'F' for 'sequence' is significant at 5% level. This seems to indicate that the first score of an individual is on the average significantly higher than the second score, irrespective of the method of observation. It may be kept in mind that the effect of varying operations is also included in the sum of squares due to sequences.

On further analysis (Table 4.2) of the sum of the squares due to 2 degrees of freedom of 'sequence' and 'methods' it appears that between sequence sum of squares for those who observe TV first, is highly significant, while the same for those who observe an operation directly first is not. Thus, TV seems to be definitely superior for those groups of students who were given the opportunity of observing an operation on TV first. But for those who viewed an operation on TV after direct observation, the total TV scores, though greater than the total direct observation scores, are not significantly different from them.

Table 4.2 ANALYSIS OF VARIANCE TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean square	F
Between sequences with TV first	31.17	1	31.17	9.96**
Between sequences with TV second	.25	1	0.25	0.08
Between operations within sequence	18.31	4	4.70	1.50
Operation x methods	8.47	5	1.69	0.54
Error	187.63	60	3.13	
Total	246.33	71		

** Significant at 1% level

As stated earlier, in the design of the experiment the 'operation effect' on comparison of methods was nullified.

It is, however, of interest to see in Table 4.1 that the differences between operations within sequence is not significant.

The analysis of variance given in Table 4.3 is based on the assumption that the error consists of 'i) differences among operations, and (ii) differences within individuals. The error sum of squares is, however, free of variation among individuals. In this Table the error mean squares is less than the error mean square in Table 4.1, because the variation among individuals seems to be of a higher magnitude as compared to variation among operations.

Table 4.3 ANALYSIS OF VARIANCE TABLE

Source of variation	Sum of squares	Degrees of Freedom	Mean Square	F
Methods	18.50	1	18.50	9.79**
Sequences	12.92	1	12.92	6.84*
Methods X Sequences	1.54	1	1.54	0.82
Error	62.42	33	1.89	
Within subjects	95.38	36		
Between subjects	150.95	35		
Total	246.33	71		

* Significant at 5% level

** Significant at 1% level

Table 4.3 confirms that the differences between TV and direct observation scores, and also the differences between sequence, are significant. The difference among methods, in this table has come out to be even more significant (significant at 1% level).

Interaction between the methods and sequence is not significant (Table 4.3) which seems to imply that the two methods and sequence are independent of each other. It may be observed from the total scores of two sequences that the differences between the average TV scores and direct observation scores - (162.0 -138.5 = 23.5 for 1st sequence and 141.5 - 128.5 = 23.0 for 2nd sequence) are of the same order in the two sequences.

Summing up, the conclusions based on analysis of variance are:

1. Rejection of the hypothesis that the two methods are equally effective, and it further suggests that viewing of operations through closed-circuit television is more effective than direct observation in the operation theatre.
2. Scores on the two methods of observation are not likely to be affected by variation in operations as the interaction between the operations and methods is not significant.
3. The first score of an individual is on the average higher than his second score irrespective of the method of observation. Further

analysis seems to reveal that TV is superior method of observation for those groups of subjects who observed an operation on TV first, as compared to the group of subjects who observed an operation through direct observation first.

4. The differences between operations within sequence is not significant.
5. Interaction between the methods and sequence is not significant, which seems to imply that the methods and sequence are independent of each other.

It is evident that the conclusions from the parametric test (analysis of variance) confirm the conclusions based on the non-parametric tests. In the parametric test certain assumptions of normality and equality of variance are made, while the non-parametric tests, though less powerful, do not involve such assumptions. It is a matter of satisfaction to note that both the methods lead to the same result.

It may, however, be pointed out that the findings of the present study are not devoid of ambiguity. In the design of the experiment care was taken to avoid the effect of practice, but in the findings the effect of sequence has come out to be significant, i.e. the scores on first observation irrespective of the method have come out to be significant. This effect was not at all anticipated. One possible explanation for the sequence effect is that there is greater motivation on the part of subjects for the first observation but it is not certain.

EFFECT OF THE No. OF PERSONS PRESENT IN OPERATION THEATRE

It struck to the investigator at a later stage that it is possible that the significant differences obtained in favour of TV are related to the number of persons present in the operation theatre. It sounds reasonable that the larger the number of persons present, in the operation theatre, the more the difficulty in viewing surgical operations directly and correspondingly the greater the chance of better observation under TV. Hence, the effect of the number of persons (Y) present in the operation theatre over the difference (X) of average TV and average direct observation scores has also been studied (Table 5). The product moment 'r' between (X) and (Y) is .885 which is significant at 5% level (and just significant at 1% level). Though this 'r' is based on only six observations, it indicates that the more the number of persons in the operation theatre, the more would be the difference between average TV and average direct observation scores. Thus the superiority of the method of observing through TV over direct observation method is likely to increase as the number of persons present in the operation theatre increases.

CONCLUSIONS

Broadly speaking, two conclusions can be drawn from the present study.

1. Observing through closed-circuit television is likely to be more effective method of viewing

Table 5 CORRELATION AMONG THE NUMBER OF PERSONS IN OPERATION THEATRE AND DIFFERENCE OF AVERAGE SCORES ON TV AND OBSERVATION.

Operation	Total scores on TV	Total scores on observation.	X Difference	Y Number of persons
A	58.0	45.0	13.0	14
B	53.5	47.5	6.0	13
C	53.5	45.0	8.5	14
D	40.5	40.0	0.5	11
E	50.5	48.5	2.0	12
F	47.5	41.0	6.5	12

r = .835**

**Significant at 1% level.

surgical operations, for undergraduate students of India medical colleges, than the present method of direct observation in the operation theatre.

2. Superiority of the method of observation through TV over the method of direct observation in the operation theatre is likely to increase with the increase in the number of persons present in the operation theatre.

LIMITATION AND SUGGESTIONS FOR FUTURE STUDY

Within the limited time and resources it was not possible to have more replications in the present study on groups of subjects from other medical colleges also, which would have given more dependable results.

It is suggested that in future studies more

replications may be made on groups of subjects from other medical colleges also. It may also be worth observing if sex and semester have anything to do with the two methods of observation. If future studies can be extended to a large number of operations relating to different parts of the human body, it will be worth observing which types of operations are best suited for televising and if funds are available a second TV camera would be an advantage in getting a continuous picture without any interference from the surgeon or his assistants. The present study cannot explain fully how the effect of sequence is significant. It is suggested that in future investigations this point should be kept in view.

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SECTION V

SUMMARY

It is a general observation in Indian medical colleges that a large number of students find it difficult to have a close-up view of the demonstrations of the delicate techniques of surgical operations. Looking at the limitations of this method of direct observation, the investigator made experimental study with the purpose to find out if more details of an operation could be seen by the observers through closed-circuit television. Statistically speaking the null hypothesis was that closed-circuit television is as effective a technique of observing surgical operations for undergraduate students of Indian medical colleges, as the method of direct observation in the operation theatre.

Thirty six subjects from All India Institute of Medical Sciences, New Delhi, were selected for the study and were divided into three groups of twelve each. Each of these three groups was further divided randomly into two equal subgroups to have two comparable groups. The subjects in one of the subgroups first observed the operation(A) through direct observation in the operation theatre and then operation(B) on television, while for those in the other subgroup, the sequence of observation was reversed. The same process was repeated for the other two groups with two more sets of operations.

To maintain contact between the surgeon and the subjects on TV a two-way sound communication system was provided. After the operation was over, a brief objective type of examination was conducted in order to know how far the subjects had learnt about that operation.

Analysis of variance rejects the null hypothesis and suggests that the method of observing operations through closed-circuit television is more effective than the method of direct observation. Generalization study also suggests that the superiority of the television over direct observation is probably due to crowding in the operation theatre.

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APPENDIX - I

SURGEON-MADE TESTS

1st Set

1. How was the appendix released and mobilised?
2. What incision was used to open the abdomen?
3. What was the peritoneal fold behind the ileo-caecal junction?
4. What kind of needle and suture was used to bury the appendicular stump?
5. What was the diagnosis at the operation table?

2nd Set

1. What procedure was carried out on the patient before the operation?
2. What were the findings at operation?
3. What steps were taken to relieve the Jaundice?
4. What was the state of liver?
5. What hollow viscous was opened and how was it stitched?

3rd Set

1. Through what route the endo-tracheal tube was passed?
2. What was done to the scar of previous incision?
3. What structures were displaced after the skin incision?
4. What was found to be wrong at the tempro-mandibular joint?
5. What methods and instruments were used to divide the bone?

4th Set

1. How big was the gap created between the temporal bone and the mandible?

3. Was anything else removed from the mandible in addition to bone chips?

3. How was the opening of the jaw carried out?

4. What type of drainage tube was left in?

5. What type of skin stitches were applied?

5th Set

1. What was the position of the patient?

2. What were the findings on opening the abdomen?

3. What was the procedure adopted to bypass the obstruction?

4. What were the different needles used to perform these procedures?

5. How was the abdomen closed? (describe the steps)

6th Set

1. What is the site of incision and what are the structures cut in succession?

2. What is the relation of the peritoneum to the bladder and ureter and how do you expose these structure?

3. How do you recognise the ureter?

4. Mention the steps to remove the stone from the ureter after exposure from the ureter?

5. Describe the closing steps of the operation?

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APPENDIX - II

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